



**PATENT**

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

**In re Application of:**

Sanderson et al.

**Serial No.:** 09/436,360

**Filed:** November 9, 1999

**For:** SYNTHESIS OF ENERGETIC  
THERMOPLASTIC ELASTOMERS  
CONTAINING BOTH POLYOXIRANE  
AND POLYOXETANE BLOCKS

**Confirmation No.:** 6505

**Examiner:** R. Sergeant

**Group Art Unit:** 1711

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**DECLARATION**

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P.O. Box 1450  
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Sir:

I, Andrew J. Sanderson, say that:

- (1) I, Andrew J. Sanderson, a co-inventor of the above-referenced patent application, am a citizen of the United Kingdom of Great Britain currently residing at <sup>3530</sup> ~~2520~~ Evergreen Trail, Blacksburg, VA 24060. I received a Ph.D. in Chemistry from the University of Exeter in 1988. I have been employed at Alliant Techsystems Inc. ("ATK") or one of its predecessor entities (Thiokol Corp. or Cordant Technologies Inc.) since 1998 and am

currently Manager of Energetic Materials Technology for ATK. ATK (or one of its predecessor entities) is the assignee of record of the above-referenced patent application.

- (2) Much of our research and development activity at ATK is directed toward producing energetic thermoplastic elastomers that are used as binders in high energy compositions.
- (3) I have read the claims of the present invention as exemplified by independent claims 1 and 43 as amended in response to the Office Action of June 17, 2004. A copy of claims 1 and 43 is attached hereto as Appendix A.
- (4) Certain of the compositions described herein include oxetane-oxirane thermoplastic elastomers and, therefore, meet or are as claimed in claims 1 and 43. The oxetane-oxirane thermoplastic elastomers of the present invention as claimed are formed from monomers of 3,3-bis(azidomethyl)oxetane ("BAMO") and glycidyl azide polymer ("GAP") or BAMO and poly(glycidyl nitrate) ("PGN").
- (5) Gun propellant compositions and explosive compositions that include either an oxetane-oxirane thermoplastic elastomer according to the present invention as claimed or an oxetane-oxetane thermoplastic elastomer were produced. Energetic properties of the compositions and the thermoplastic elastomers were determined. The oxetane-oxirane thermoplastic elastomers included monomers of BAMO and GAP or BAMO and PGN. Compositions including these oxetane-oxirane thermoplastic elastomers are exemplified by or meet the limitations of claims 1 and 43. The oxetane-oxetane thermoplastic elastomers included BAMO and 3-azidomethyl-3-methyloxetane ("AMMO") or BAMO and 3-nitratomethyl-3-methyloxetane ("NMMO"). The gun propellant compositions and explosive compositions also included cyclotrimethylene trinitramine ("RDX") or cyclotetramethylene tetranitramine ("HMX").

- (6) Energetic properties of the gun propellant compositions were calculated, as shown in Table 1.

Table 1: Calculated Properties of the Gun Propellant Compositions.

Composition	Solids (%)	$\rho$ (g/cc)	I (J/g)
JA2	0	1.57	1151
BAMO-AMMO/RDX	75	1.604	1167
BAMO-NMMO/RDX	75	1.649	1258
BAMO-GAP/RDX	75	1.644	1289
BAMO-PGN/RDX	75	1.692	1307

JA2 is a composition that includes nitrocellulose, nitroglycerin, and diethylene glycol dinitrate and was used as a reference. As shown by the impetus ("I") values, the gun propellant compositions that included the oxetane-oxirane thermoplastic elastomers (the BAMO-GAP/RDX composition and the BAMO-PGN/RDX composition) had increased energetic performance compared to the gun propellant compositions that included the oxetane-oxetane thermoplastic elastomers (the BAMO-AMMO/RDX composition and the BAMO-NMMO/RDX composition).

- (7) Burning rates of the thermoplastic elastomers were also measured, as shown in Table 2.

Table 2: Measured Burning Rates of the Thermoplastic Elastomers						
Thermoplastic Elastomer	Burning Rate (in/sec) @ (psi)					
	500	1000	2000	3000	6000	9000
BAMO-AMMO (25% BAMO)	0.182	0.259	0.358	0.381		
BAMO-GAP (25% BAMO)	0.463	0.760	0.986	1.120	1.433	1.294
BAMO-PGN (25% BAMO)	0.235	0.329		0.654	0.800	1.078

Table 2 shows that the measured burning rates of the oxetane-oxirane thermoplastic elastomers (the BAMO-GAP and the BAMO-PGN thermoplastic elastomers) were higher than those of the oxetane-oxetane thermoplastic elastomer (the BAMO-AMMO thermoplastic elastomer).

- (8) Detonation properties of the explosive compositions were also calculated, as shown in Table 3.

Table 3: Calculated Detonation Properties of Model Explosives					
Composition	Solids (%)	$\rho$ (g/cc)	$P_{cj}$ (Gpa)	$V_{cj}$ (mm/ $\mu$ sec)	$\Delta E$ @ $V/V_o$ = 6.5 (kJ/cc)
PAX-2A	85	1.780	31.71	8.428	7.87
BAMO-AMMO/HMX	85	1.751	29.71	8.308	7.74
BAMO-NMMO/HMX	85	1.783	31.46	8.488	8.09
BAMO-GAP/HMX	85	1.779	31.81	8.539	8.15
BAMO-PGN/HMX	85	1.813	33.36	8.704	8.44

PAX-2A is a composition that includes HMX, cellulose acetate butyrate (“CAB”), and bis(dinitropropyl acetal/-bis(dinitropropyl formal) (“BDNPA/F”) and was used as a reference. As shown in Table 3, the densities, detonation pressures, detonation velocities, and detonation energies of the explosive compositions that included the oxetane-oxirane thermoplastic elastomers (the BAMO-GAP/HMX and BAMO-PGN/HMX compositions) were higher than those of the explosive compositions that included the oxetane-oxetane thermoplastic elastomers (the BAMO-AMMO/HMX and BAMO-NMMO/HMX compositions).

- (9) As shown in Tables 1-3, the thermoplastic elastomers of the present invention and as claimed in independent claims 1 and 43 had improved energetic performance compared to thermoplastic elastomers formed from oxetane and oxetane monomers, such as those disclosed in United States Patent No. 4,806,613 to Wardle (“Wardle”).
- (10) Using the oxetane and oxirane monomers to form the thermoplastic elastomers of the present invention as claimed provided an unexpected improvement in energetic performance compared to that of the thermoplastic elastomers formed from oxetane and oxetane monomers.

- (11) The improvement in energetic performance observed with the thermoplastic elastomers of the present invention as claimed was unexpected because, based on the teachings of Wardle, U.S. Patent No. 4,976,794 to Biddle *et al.* ("Biddle"), and U.S. Patent No. 5,747,603 to Hinshaw *et al.* ("Hinshaw"), one of ordinary skill in the art would only have expected comparable or similar energetic performance between the thermoplastic elastomers of the present invention and the oxetane-oxetane thermoplastic elastomers.
- (12) Since the thermoplastic elastomers of the present invention as claimed provided increased impetus compared to the oxetane-oxetane thermoplastic elastomers, the thermoplastic elastomers of the present invention have significant, practical advantage when used as the binder in a gun propellant composition.
- (13) Since the thermoplastic elastomers of the present invention as claimed had increased burning rates compared to the oxetane-oxetane thermoplastic elastomers, the thermoplastic elastomers of the present invention have significant, practical advantage when used as the binder in a high energy composition.
- (14) Since the thermoplastic elastomers of the present invention as claimed had increased densities, detonation pressures, detonation velocities, and detonation energies compared to the oxetane-oxetane thermoplastic elastomers, the thermoplastic elastomers of the present invention have significant, practical advantage when used as the binder in an explosive composition.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.



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Andrew J. Sanderson

12 - 15 - 04

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Date